



**TITLE: Splitting Atoms**

**Subtitle: Forming Arguments from Evidence to Address Nuclear Energy Policy**

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**Field tested with:** 11<sup>th</sup> & 12<sup>th</sup> grade Government students, Watsonville High School, Watsonville, CA, Fall 2013

**Module Type:** Short lecture and classroom activity

**Duration:** one 2-h class session

**Key materials:**

- Computer with Microsoft PowerPoint)
- Access to internet for video embedded in introduction lecture
- Interest group title and descriptions document (2-3 copies)
- Student readings (one per student; or at least two per group)
- Student worksheet (one per student)
- Butcher paper for student posters (1 piece per group of 4-5 students)
- Scissors
- Markers
- Glue or tape

**Concepts:** Nuclear energy, energy supply, climate change, environmental risk, energy policy, nuclear waste, federalism, constituents, interest groups,

**Skills:** Critical analysis, debate, discussion, oral presentation skills, forming arguments from evidence, communicating arguments from evidence

**Next Generation Science Standards (NGSS):**

Disciplinary Core Ideas

ESS3C: Human Impacts on Earth Systems (HS-ESS3-4)

Crosscutting Concepts

Influence of Science, Engineering, and Technology on Society and the Natural World

Science and Engineering Practices

Engaging in Argument from Evidence

Constructing Explanations and Designing Solutions

•**National:** A, F

•**California:**

Science Standards

Investigation and Experimentation 1.d., 1.m.

History-Social Science

Principles of American Democracy 12.6.4

Principles of Economics 12.1.1

### Overview:

Students learn about the source of energy within the U.S. with a focus on the potential benefits and risks associated with expansion of nuclear-generated energy. Students are presented with the question, “should the federal government appropriate funds for nuclear energy development. The class is divided into groups, each one representing the views of an interest group that either supports or opposes the expansion of nuclear-generated energy in the U.S. Students then review an objective overview of the potential benefits and risks of nuclear energy expansion. They respond to some general questions regarding the benefits and risks of nuclear energy, the primary sources of energy supplies in the U.S., the role of economics in determining energy supply portfolios. Finally, each group forms arguments and extracts evidence from the reading to support their position on the Essential Question. Each group prepares a poster to display their group’s stance on the issue, and presents their findings to fellow classmates. The activity concludes with the identification of counterclaims to their arguments and preparation of concluding remarks. This project is an opportunity for students to learn:

- How to formulate arguments from evidence.
- How to examine different views from a range of interest groups.
- How to evaluate a U.S. policy statement from an interest group perspective.
- How to understand the issues surrounding public policy decisions and the potential challenges of finding a political solution in a democratic society.

**Navigate:** [Background](#) [Materials &Time](#) [Starting Point](#) [Procedures](#) [Standards](#) [Supplemental](#)

## Background for Teachers

**Why this matters:** The process of developing public policy is often informed by the input of a diverse network of stakeholders. Private businesses, nongovernmental organizations, the scientific community and the role of government institutions each represent an important perspective that is often considered by legislative bodies and regulatory agencies when writing laws and rules to address societal issues. Law and policy makers are often faced with the challenge of addressing problems that have positive and negative implications for various stakeholders, and are charged with the challenge of developing rules and mechanisms that generally protect the public interest. It is important for students to understand the role that interest groups play in the framing of problems during the policymaking process, and the fact that seeking to solve societal issues often pose challenges for policymakers that want to minimize negative impacts to avoid a zero-sum game.

### Assumed background:

- Capable of extracting facts and information from reports/documents
- Ability to develop arguments from evidence
- Prior knowledge of the Legislative Branch
  - Congress & House of Representatives
- Understanding of the concept of federalism
- Understanding of the principles of economics
- Understanding of supply and demand curves

**Special context:** In this activity, students will be exposed to **interest group perspectives** as it relates to the **nuclear energy policy**. Nuclear energy policy is particularly interesting in the context of



environmental policymaking, as this energy production method poses potentially significant benefits and risks to society and the environment. The relatively significant reduction in **greenhouse gas emissions** of a national energy portfolio that becomes more reliant on nuclear energy presents a tremendous opportunity to address the issue of **global climate change** by replacing fossil fuel-generated energy. In addition growth in this energy sector could potentially reduce reliance on foreign supplies of fossil fuels, increasing the nation's energy security. However, there are significant risks associated with the expansion of nuclear energy production. Key environmental and human health issues are related to the potential for nuclear meltdowns, and the subsequent release of radioactive material into the environment. The safe disposal of nuclear waste is also an important environmental issue that has been highly contentious in the policymaking arena. Historically these kinds of policy issues require **legislative bodies** or **regulatory agencies** to address the **negative externalities** of a particular practice in order to protect human health and/or the environment. Addressing the negative externalities of environmental impacts or risks requires the allocation of **government funding** (e.g. subsidies) application of **command-and-control** (e.g. technology or performance standards) or **market-based** (e.g. taxes or cap-and-trade programs) policy instruments, which have economic consequences for particular industries or interest groups. The role that interest groups play in framing these issues, by presenting arguments from evidence, often plays an important role in the policymaking process via political lobbying, media campaigns and public outreach. This module provides a framework to analyze nuclear energy as a national policy in which students take on the role of interest groups to support or oppose the appropriation of federal funds to support nuclear energy development.

### Scaffolding supplements:

## Module Description

### Materials:

- Computer with Microsoft PowerPoint)
- Access to internet for video embedded in introduction lecture
- Interest group title and descriptions document (2-3 copies)
- Student readings (one per student; or at least two per group)
- Student worksheet (one per student)
- Butcher paper for student posters (1 piece per group of 4-5 students)
- Scissors
- Markers
- Glue or tape

### Preparation:

- Interest group title and description documents (2-3 copies; 4 groups per copy), student readings (one per student; or at least two per group) and student worksheets (one per student) must be printed. Butcher paper, or large sheets for student posters will be needed. Scissors, markers and glue are convenient but not mandatory.

### Timeline:

- Nuclear energy introductory lecture and “Essential Question” – 10-15 minutes
- Students form groups and receive materials (4-5 students per group) – 5 minutes
- Students review reading, fill out worksheet and prepare posters in groups - 60 minutes
- Groups present posters and identify counterclaims – 15 minutes
- Groups record counterclaims and provide a closing argument – 10 minutes
- Groups present closing argument using evidence, counterclaims and conclusions – 10 min



### Starting Point For Inquiry:

Use the introductory lecture to introduce the basics of nuclear energy. Confirm that the students understand the basics of nuclear fission, and the low emissions characteristics of this energy production method compared to energy produced from fossil fuels. Ask them: “Why is the low emissions of nuclear energy important in the context of global climate change?”

Conclude the lecture with the Essential Question: “Should the federal government appropriate funds to support nuclear energy?”

Tell the class that they will conduct their own investigation regarding the benefits and risks of nuclear energy. Inform them that they will be representing the perspectives of stakeholder groups to address the Essential Question. Some groups will be opposed to funding nuclear energy, while others will be in favor. Their goal is to use the reading to formulate arguments in response to the Essential Question and provide evidence to support their arguments. Students should be reminded of the importance of interest groups in the policymaking process.

Let students know the plan for the day: they will be working in groups, completing individual worksheets and preparing and presenting group posters.

### Detailed Procedure:

1. The instructor presents the introductory lecture to the class. The lecture begins by introducing the topic of nuclear energy and providing basic background on the physical and mechanical processes that are used to generate energy from nuclear fission. The lecture concludes by posing the Essential Question that students will be investigating.
2. Students form groups of 4-5. Instructors provide each group with the materials for the activity. Interest groups can be assigned to student groups randomly. There should be at least two interest groups in favor of (one environmental, one business) and two groups that are opposed to nuclear energy (one environmental, one business).
3. The instructor should allow the students to work in groups to complete the student worksheets and construct group posters. Students who are less familiar with economic principles and supply and demand curves may struggle with page 2 of the worksheet. The general answer to the economic question posed here is that supply plays an important role in determining price for resources such as oil and gas. A decrease in the supply of oil will generally result in an increase in prices, this is important because the price may increase such that price of nuclear is now less than oil, potentially leading to an increase in demand for this energy resource. Oil and gas markets are known to be volatile, whereas the nuclear energy market is not.
4. Once students have completed the first 3 pages of the worksheet and have prepared their posters, the instructor should assist with hanging the posters throughout the room. Students are instructed to leave one group member with the poster while the other group members visit posters with opposing views on nuclear energy policy to collect counterclaims.
5. Once each group has collected at least two counterclaims, groups should reconvene at their desks and prepare their closing argument. A concluding remark should include at least one argument that supports their view on the Essential Question, supported by some evidence relevant to the argument. The concluding remark should also include a counterclaim from an opposing view, and a concluding remark should include a rebuttal to the counterclaim, propose a policy solution that will address the counterclaim or offer a compromise.



- Each group should present their closing argument to the class. The instructor should conclude the activity by highlighting opportunities for policy solutions to address counterclaims (e.g. increased safety measures to reduce risk of a nuclear spill or meltdown), and opportunities for compromise between opposing groups.

### **Assessment Methods:**

Assessment of student arguments and supporting evidence can be evaluated during the poster presentation portion of the activity. The instructor should roam around the room and engage in discussion with groups along with other students and encourage others to question the argument and conclusions made from the evidence. Assessment of student performance can also be carried out by collecting individual worksheets, and reviewing the quality and accuracy of the responses. In general, circulating the room and assisting students/groups who appear to be struggling with the material is recommended.

### Possible pitfalls:

Students may have difficulty getting through the reading material. The reading is divided into sections, so groups can be encouraged to work collaboratively and divide the reading into the separate nuclear energy issues.

Students may be less comfortable with the economics portion of the worksheet. If a majority of the students seem to be struggling to get through this portion of the worksheet, it is recommended that the instructor pause the group work, and answer the questions as a class.

### Glossary:

Emission - The production and discharge of something, esp. gas or radiation.

Externality - A side effect or consequence of an industrial or commercial activity that affects other parties without this being reflected in the cost of the goods or services involved.

Nuclear fission – A nuclear reaction in which a heavy nucleus splits spontaneously or on impact with another particle, with the release of energy.

Policy solution- A policy instrument such as a tax, command-and-control regulation, subsidy etc. that is implemented to change a specific condition in society.

## Science Education Standards Addressed

### **Next Generation Science Standards (NGSS)**

#### Disciplinary Core Ideas

#### ESS3C: Human Impacts on Earth Systems

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems (**HS-ESS3-4**)

#### Crosscutting Concepts

### **Influence of Science, Engineering, and Technology on Society and the Natural World**

Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks (HS-ESS3-4)

#### Science and Engineering Practices



### Engaging in Argument from Evidence

- Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2)

### Constructing Explanations and Designing Solutions

- Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations

### National Science Standards (NSES)

A. Science As Inquiry (p.175-176)

F. Science in Personal and Social Perspectives (p.198-199)

### California Public Schools Standards (SCSCPS)

#### Science Standards

Investigation and Experimentation, 1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing content in the other four strands, students should develop their own questions and perform investigations. Students will:

- d. Formulate explanations by using logic and evidence.
- m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

#### History-Social Science

Principles of American Democracy 12.6.4 Students evaluate issues regarding campaigns for national, state, and local elective offices.

- d. Describe the means that citizens use to participate in the political process (e.g., voting, campaigning, lobbying, filing a legal challenge, demonstrating, petitioning, picketing, running for political office).

Principles of Economics 12.1.1 Students understand common economic terms and concepts and economic reasoning.

1. Examine the causal relationship between scarcity and the need for choices.



## Guide to Supplemental Materials

### Lecture

The instructor should use the introductory PowerPoint presentation to begin the module. The presentation provides a basic introduction to the physical and mechanical processes that are used to produce nuclear energy, including components of a nuclear power plant facility and the process of nuclear fission. The presentation also provides a general overview of nuclear-generated energy in the U.S. using maps.

File name: Splitting Atoms\_intro.ppt

### Worksheet

Each student will receive a worksheet to guide them through their investigation and to assist in organizing and structuring their arguments and evidence for the poster.

File name: Splitting Atoms\_worksheet.pdf

### Reading

The reading material is an essential component of the module as it provides a relatively thorough and objective overview of the role of nuclear-generated energy in the U.S. and the potential benefits and risks associated with this energy production method.

Citation information: Ferguson, Charles D. 2007. Nuclear Energy: Balancing Benefits and Risks. Council on Foreign Relations. New York, NY

File name: Splitting Atoms\_reading.pdf

### Group Names and Descriptions

The group names and descriptions document is not essential, but provides the instructor with a simple way to divide the class into pro/con groups in a meaningful way. The descriptions provide students with the basic information that they need in order to decide what interests they are representing throughout the activity.

File name: Splitting Atoms\_group names.pdf

NSES (<http://www.nap.edu/catalog/4962.html>)

SCSCPS (<http://www.cde.ca.gov/be/st/ss/documents/sciencestnd.pdf>);

